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Notes on Maize.

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I.

The words *Zea Mays* are only fitted for generic use. So numerous and divergent in appearance and use are the varieties of corn already known that to call all by one name is to speak too indefinitely for any practical purpose. *Zea Mays* may mean the dwarf pop growing but eighteen inches tall in our gardens, or the huge something which is reported as over twenty-four feet tall in Central America—a variety so hard that the national custom is to parch before attempting to pulverize, or so soft as to readily reduce to meal on a hollow stone—a variety which, despite extensive distribution, cannot compete with a commercial form, or a form which enters into commerce—a variety whose hundred kernels weigh but 46 grains, or another whose hundred kernels weigh 1531 grains. If we consult botanies we find nothing of any help towards determining questions of climatic relation, of adaptability or environmental reaction. If we examine pages of travel, of archeology, of ethnology or of history, we fare scarcely better in securing sufficient preciseness of mention for purposes of study. From whatever point of view we attempt an examination into the natural and economic history of the maize plant and product, we meet with difficulties, usually insurmountable, arising from indefinitiveness of nomenclature.

It seems the universal experience that scientific investigation cannot be well accomplished without a distinct and sufficient nomenclature. The lack of precise names for cultivated plants has served to discourage study, and to discredit much of the work which has been inefficiently attempted. Systematic botanists at present seem to endeavor to mass divergent forms into a common species. As valuable as this attempt may be for wild plants, yet when applied to cultivated plants the tendency is to form groups too unwieldy for the purpose of those who would study into causes and effects of changed environments. For the successful study of plants of economic relation and great variability there is need of a precise system of nomenclature, and the only at present requisite is the absolute and ready delimitation of groups under a name system approved by botanists, and which shall not become perverted by popular use, as is the likelihood with vernacular names. In the present jejune condition of agricultural botany we may properly leave for future discussion those questions relating to genealogy, and be satisfied with a system that is accurate and convenient, and which shall enable us to record observations and results of study in a form available for use. I have hence sought for an improved nomenclature for maize, and the longer acquaintance I have had with my groups the more justified I am in my belief that in convenience and availability they leave but little to be desired.

From a botanical standpoint, I am disposed to accept *Zea tunicata* as a primitive form, from which are derived: *Zea everta*, the pop corns; *Zea indurata*, the flint corns; *Zea indentata*, the dent corns; *Zea amylacea*, the soft corns; *Zea saccharata*, the sweet corns; and *Zea amyleasaccharata*, the starchy-sweet corns.

Each one of five of these species furnishes three well-defined sub-species, with parallel relationship throughout. Thus, sub-species A, the kernel broader than deep; sub-species B, the kernel as broad as deep; sub-species C, the kernel much deeper than broad. All my collections concur towards the belief that climatic relations are more evident in these sub-species than in the species themselves. With the possible exception of the dent corns and the starchy-sweet, for which but one locality is as yet known, the climatic range and adaptability seem about the same, but in the

sub-species there is diversity, A being for climates of short season, C for long seasons, while B in general is intermediate, although a climate suitable for C can grow A and B. Sub-species A is the only kind represented in our more Northern collections of *Z. indurata* from Lake of the Woods, Northeastern Canada and North Dakota; of *Z. amylacea* from Manitoba; of *Z. indentata* from North Dakota; of *Z. saccharata* from Northern Maine and Northern Minnesota. Sub-species B comes from a little south of the before-mentioned range, and extending south especially throughout the elevated regions. Sub-species C is yet more southern, and rarely comes to me from regions of short season.

The number of varieties of Indian growing, or of Indian origin, which I have seen or collected, appear in the annexed table:

	<i>Zea everta.</i>	<i>Zea indurata.</i>	<i>Zea indentata.</i>	<i>Zea amylacea.</i>	<i>Zea saccharata.</i>	<i>Zea amylaeasaccharata.</i>
Arizona cliff-dwellers (Nat. Mus.), Seen.				1		
Arizona Indian (From Dr. Vasey)				5		
Brazil Indian, San Paulo (From Prof. Derby) . . .				2		
Cocopa Indian, Mexico (From Dr. Palmer)				3		
Dacota Indian, Fort Lincoln		1				
Guadalajara Indian, Mexico (From Dr. Palmer) . .				1		
Illinois Indian, Wyandotte				1		
Michigan Indian, Squaw				1		
New England Indian		4				
North Carolina Indian, Tuscarora in three colors .				3		
Omaha Indian, Nebraska Black				1		
Peruvian. Mummy Cuzco				2		
San Pedro Indian, Mexico (From Dr. Palmer) . . .		1	7	4		3
Sioux Indian, Golden Sioux		1				
Susquehanna Indian. Eight-rowed sweet					1	
Tarahumarer Indian, Mexico (From Dr. Palmer) . .		2	1	5		
Tesuque, Pueblo, 1892, Seen.				6		
Yacqui Indian, Mexico (From Dr. Palmer)		1				
Zuni Indian, New Mexico (From Mr. Cushing) . .				6		
Totals	0	10	8	41	1	3

Dr. Edward Palmer, in a letter accompanying the Cocopa Indian corn, wrote that the same varieties were cultivated by the Mohave, Pima and Yuma Indians of the United States.

From my reading I think it is reasonably safe, although somewhat conjectural, to identify references to our species, as follows:

	<i>Zea everta.</i>	<i>Zea indurata.</i>	<i>Zea indentata.</i>	<i>Zea amylacea.</i>	<i>Zea saccharata.</i>
Canada Indian,		2			
Cliff-dwellers,	1		1	2	
Guaranies, of Paraguay,	2	1		1	
Honduras Indian,		1			
Mandan Indian,	1	1			
Mexican Indian,					1
New England Indian,		3			
Peruvian Indian,	2	4	1	6	1
Pueblo Indian,				3	
Virginian Indian,		1	1		
West Indian. Hispaniola,				1	
Totals,	6	13	3	13	2

The species described or mentioned by me in the Report of the New York Agricultural Experimental Station, 1884, with figures and diagrams of 126 varieties, are thus represented in tabular form:

	Sub-species A.	Sub-species B.	Sub-species C.	Totals.
<i>Zea everta</i> , Pop corns,	4	5	19	28
<i>Zea indurata</i> , Flint corns, . .	27	9	8	44
<i>Zea indentata</i> , Dent corns, . .	8	2	38	48
<i>Zea amylacea</i> , Soft corns, . .	7	5	2	14
<i>Zea saccharata</i> , Sweet corns, .	14	12	8	34
Totals,	60	33	75	168

I have since received from Chili, one variety soft corn, sub-species B., and four varieties soft corn, sub-species C.

The regermination of cornseed, after drying, has a bearing on the question of the distribution of the seed in nature. Some

trials in 1883 showed that sprouted seed air-dried for seven days, and then replanted, would renew growth. The per cent. germinating at the successive trials were as follows:

	Germination per cent., same seed, each trial.					Total days air-dried.	
	I.	II.	III.	IV.	V.	VI.	
Flint varieties, . . .	99	96	63	30	22	0	33
Dent " . . .	80	78	14	21	0	0	24
Rice pop,	100	96	29	43	44	0	28

The comparative hardiness and prolificacy of our species, as determined under similar conditions of spacing and planting, is seen below.

	Varieties or Selections Tested.	No. of Seed Planted.	No. of Mature Plants Furnished.	No. of Good Ears in Crop.
<i>Zea everta</i> ,	15	712	625 or 88 per cent.	670 or 1.07 per plant.
<i>Zea indurata</i> ,	11	504	373 or 74 " "	290 or 0.77 " "
<i>Zea indenta</i> ,	20	1312	606 or 46 " "	409 or 0.67 " "
<i>Zea amylacea</i> (Tuscarora),	6	263	86 or 32 " "	134 or 1.55 " "
<i>Zea saccharata</i> ,	27	1176	726 or 62 " "	756 or 1.04 " "
<i>Zea tunicata</i> (Dent form),	9	400	166 or 41 " "	105 or 0.63 " "

These results for prolificacy are not, however, strictly comparable, as prolificacy is determined largely by the spacing of the plants. Thus in a trial with Waushakum flint corn.

1	plant, per hill, the yield per plant, 3.5 good ears and 1.1 poor ears.
2	" " " " " " " 2.1 " " " 0.8 " "
3	" " " " " " " 1.5 " " " 0.4 " "
4	" " " " " " " 1.2 " " " 0.2 " "
5	" " " " " " " 1.0 " " " 0.2 " "

Most sorts of corn will germinate when quite unripe, in the milk or before hardening of the kernels has taken place. The more flinty the corn the earlier and more certainly does the germination occur. The order in my trials has been flint, sweet, dent.

As to distribution by countries my information is very incomplete. The varieties that are represented in my collections are as follows:

	Pop.	Flint.	Dent.	Soft.	Sweet.	Starchy-sweet.	Totals.
From Africa,	—	7	1	—	—	—	8
“ Brazil,	2	3	1	2	—	—	8
“ Chili,	—	—	—	6	—	—	6
“ France,	4	5	2	2	1	—	14
“ Peru,	—	—	—	2	—	—	2
“ Mexican Indian,	—	4	8	13	—	3	28
“ Venezuela,	—	—	2	—	—	—	—
“ U. S. Indian,	—	6	—	17	1	—	24
“ U. S. Cultivation, 1884,							
1885,	13	46	45	4	43	—	151
Totals,	19	71	59	46	45	3	243

The hour at which first germination was noted at various temperatures, for each species, is given in the following table, the temperatures being the extremes during the trials :

	41°-43.7° F.	45.3°-50.7° F.	48.5°-58.5° F.
<i>Zea everta</i> .—Dwarf Golden,	498	228	141
White Pearl,	378	228	141
Amber Rice,	378	228	141
<i>Zea indurata</i> .—Wauashakum, . . .	331	228	142
Eight-rowed White,	331	216	150
<i>Zea indentata</i> .—Adam's Early, . .	233	180	142
Chester Co. Mammoth, . . .	233	168	142
<i>Zea amylacea</i> .—Tuscarora,	378	228	161
Zuni Blue,	431	228	185
<i>Zea saccharata</i> .—Stowell's Evergreen, .	452	288	195
Narragansett,	498	300	209

II.

Zea everta, the Pop Corns. N. Y. Ex. Sta. 1884, 183; 1882, 59, fig.

The kernel split laterally shows the chit and corneous matter enveloping. In some cases a fine starchy line. The small size of the kernel and the property of “popping” makes identification certain.

Zea curagua Molin. Bonafous, Mais, 1836, 29. (A pearl pop.)

Zea Mays Lam. Ill. 1823, t. 749, fig. f. (A twelve-rowed pop.)

Zea hirta Bonaf. l. c. t. 4. (A pearl pop.)

Zea rostrata Bonaf. l. c. 32. (A rice pop.)

Zea Mays præcox Bonaf. l. c. (A golden pop.)

Zea Mays minima Bonaf. l. c. (A dwarf-golden pop.)

Zea canina Wats. Proc. Am. Acad. 26: 161. (A rice pop.)

The common eight-rowed pop seems to have no history, although probably in cultivation in New England from early times. It belongs to sub-species A. The plants frequently bear several ears to a stalk and are subject to monstrous growth. The twelve-rowed, a representative of sub-species B, also seems to have no history. Under the name of small white, Salisbury, 1848, says it bears from three to seven ears to a stalk. A lemon-yellow form is the milho pepoca, of Brazil. Sub-species C has the largest representation. It comprises the mais quarantino of France, at least in the samples I have received, and the mais nain, mais a poulet of the French; the cinquanto, sessantino and torquetto of Italy, probably. In Mexico, under mais cuarentano, Heller gives Mexican names of varieties as mais tremes and olote colorado. The golden pop group are distinguished by small size of ear and kernel and extreme earliness. Hence we may mention here, without certainty as to the species, early maturing varieties. Humboldt quotes Oviedo as having seen in Nicaragua a variety ripening in 30 or 40 days, says that he remembers finding this variety on the banks of the Amazon, and that in Hungary there is a two months' variety. Dalechamp, 1587, refers to a variety that matures in two months, and another less grown which ripens in 40 days. Porta, in his Villæ, 1592, refers to a six weeks' and two months' corn. Lery, in his Brazil, 1594, names a 45 day corn. Morison, 1699, describes from America the "Rathripe" corn. Dobrezhoffer, 1749, mentions in Paraguay, the abati miri, which ripens in a month, but has very small dwarfish grains. Catlin describes finding among the Mandan Indians an early corn with ears as long as a man's thumb. Nuttall calls this *Zea Mays præcox*, a name which Bonafous repeats for a golden pop variety. The corn of Lake Titicaca, described by Squier as dwarf and hard grained, is almost certainly a pop. The golden pop varieties when grown in pots usually develop tassel corn in my experience. Hence we note here that Parkinson, 1640, describes the *Frumentum indicum alterum minus*, as grown in the unfavorable English climate, as not bearing crop "at the joynts of the stalkes as the other, but at the toppes following the flowers." This variety was not known to Ray, 1688, and he doubts the description and classes with *Frumentum indicum may dictum minus*, C. Bauhin, 1623. The pearl pop group is distin-

guished by the dense aggregation of the kernels and their nacre-like lustre. Molina calls it the stone maize. Samples from Rio Claro, Brazil, were labeled milho perola. In California I have seen on exhibition stalks bearing up to nine ears. The Mapledale Prolific, which seems to belong here, is figured by a seedsman in 1890, with sixteen ears on a stalk, some of the ears clustered two in an axil; an affidavit accompanying says that 10 stalks had 121 ears, and one stalk 19 ears. The rice pops are peculiar for their pointed kernels, and the tendency to yield cone-form ears with imbricated kernels. They seem ancient in Peru, as having been found in sculpture. Rivers and Tschudi say that the rice pop kind and cone-shaped ears were considered as sacred things and were buried with mummies by the Peruvians. Dobrezhoffer, 1749, says that in Paraguay the kind with pointed kernels was called bisingallo. A noticeable feature of the rice pop is the tendency to sport. Frequently half the ears of a garden crop will be flattened or digitate at their apex, and in the Bear's Foot variety this tendency has become permanent to form a flat ear. There is also a tendency in the plant to form branches, or to bear aggregate ears, or to develop tassel corn, and occasionally tassel ears. The Monarch White Rice, as advertised in 1887, is figured as bearing tassel ears and also seven ears on a stalk. When grown separately the plants usually sucker greatly. The description of the kernels of *Zea canina* Wats. as "small, white, hard and smooth, ovate, acutish, constricted at base," would apply to this class, but the "ears small, 4 to 12-rowed," offer a variety not yet known to me. His other characters, except as to the spikelets and glumes which I have not looked for, do not differ from characters to be observed in all our species as of frequent or exceptional occurrence, and especially in *Zea tunicata*. The few kernels in the herbarium specimens of *Zea canina*, presented me by Professor Watson, are distinctly of the rice pop type, and a peculiarity overlooked by Professor Watson, or more likely not present in the ears that underwent his examination, some are podded. If we reason closely from this statement, we may class *Zea canina* Wats. with my *Zea everta*, with the appearance of *Zea tunicata* as an atavism. The *Mais rosero*, a pop corn observed by Professor Duges as cultivated in the region (Mexico) where *Zea canina* was collected, we only know by name.

Some varieties of sorghum seed, such as "rice wheat," have the property of popping like pop-corn; so also the seeds of *Amarantus leucospermus* Wats., and are thus used in Mexico.

III.

Zea indurata, the flint corns, N. Y. Ex. Sta. 1884, 164: 1886, 59, *fig.*

The split kernel exhibits the chit, starchy matter, and a cornaceous matter enveloping. It cannot be confounded with any other species except the pop, from which it is distinguished by the larger kernel and inability to "pop."

Mays Zea Gärtn. Fr. 1788, *t.* 1.; also same figures, *Mays* Tourn. Inst. 1719. *t.* 305: *Zea Mays*, Lam. Ill. 1823, *t.* 749, *fig. h.*

Turcicum frumentum Fuchs. Hist. 1542, 825 and as copies, Fuchs, Hist. 1549, 783; 1551, 783; *imag.* 1545, 476; *pl. effig.* 1549, 476; *Milium indicum*, Dod. frugum, 1552, 35; post, 1554, 10; *Fru-mentum turcicum*, Lyte's Dod. 1578, 464; *Triticum Indicum Fuchsii*, Lugd. 1587, 382; *Triticum Indicum*, J. Bauh. 1650, 2, 453; *Triticum turcicum vel indianum*, Chabr. 1666, 174; 1673, 174.

Frumentum turcicum Blackw. herb. 1773, *t.* 547.

I find no synonyms for our vernacular "flint corn." It is the Indian corn, in yellow, red and blue or blue-mixed varieties found by the Pilgrims as mentioned by Mouart and Higginson; the Indian wheat, yellow, red and blue of Josselyn. Cartier, 1535, found two varieties in or near the present Montreal, one called *offici*, as big as small peas, and hence probably our Canada Twelve-rowed; the other called *carracony*, as great and somewhat bigger than small peason, hence the Canada Eight-rowed. Heriot, 1588, in Virginia, under the name *pagatour* seems to describe a flint corn. This species is probably the *Mays minor*, with yellow, red and blue colors, which ripens in England in four months, as recorded in Miller's dictionary, editions of 1731, 1748 and 1752; the *Zea vulgare*, *caule humiliore*, etc., of the edition of 1771, the ears 4 to 5 inches long, the kernels yellowish white, deep yellow, purple, blue and mixed, ripening in England. The Mandan Indian corn, as described by Salisbury, seems to be a flint, and a flint corn under the name of Mandan has come to me from Fort

Lincoln, Dakota.* Du Pratz, 1763, describes white, yellow, red and blue homony corn in Louisiana. The San Padro Indians of Mexico cultivate a flint variety, the Tarahumarer Indians two varieties and the Yacqui Indians one, as represented in my collections. The common corn of Honduras is described by Squier as a flint. In Guatemala, Brigham found a variety of large kernelled corn like "rice corn," a form which I have never seen. In Paraguay the Guaranies have an abati hata, 'composed of very hard grains.' In Peru, DeVega says the Indians have a hard kind called muruchu. Tschudi seems to describe a flint corn under the name morocha, and Herndon and Gibbon describe the mais morocha at Tarma as with small grain, red, white, yellow and blue, which is parched, forming cancha or "toasted maize." The Topover corn, a very distinct and peculiar variety, with eight or ten rows, was claimed to have originated in Nantucket, and was first brought to notice in 1884. In 1886, I found a yellow and a white Ten-rowed Topover in the Tarahumarer Indian collection sent me by Dr. Palmer.

I have noticed more sports in this species than in the others, because it is the one I have cultivated in my farming. I have figured in the *Scientific Farmer*, October, 1878, a tassel bearing grain, a tassel undergoing partial transformation into ear, and one converted into a tassel ear; also four ears developed in a bunch from the upper node. Mention is also made of the extremity of an ear bearing a tassel, and in the New York Experiment Station Report, 1883, 40, of an ear of New England twelve-rowed, eight inches long, then one and a quarter inches of tassel, and at the end of this tassel another well formed ear three inches long. In other varieties, a branch may occur on the leaf axil bearing a terminal ear and one or more at the nodes below, and in 1879 I had a branch with one terminal and three nodal ears. By compressing the pith of a growing plant this branching may be greatly stimulated. One variety, the Vermont yellow, is described as bearing its ear normally on a branch two feet long. Occasionally two

* May 14, 1894, Dr. Wm. Saunders, Director of the Experimental Farm, Canada, sent me a sample of the Squaw corn grown at Rat Portage, Lake of the Woods, about 50° N., which corresponds with the Mandan flint, and is a shorter and smaller ear of the common Northern New England Eight-rowed. The ear was 6½ inches long and kernels large.

ears, more rarely a bunch of ears appear at a node, but in such cases they all do not fertilize. Digitate and branching ears are not very uncommon. In some cases two ears joined at their base, in others three or more; more rarely a whole group is so joined as to form a cup lined both inside and outside with kernels. In eight-rowed varieties four-rowed ears are sometimes found, the ear then flattened and distichous. Six-rowed ears are also found, and such have a tendency to develop the rows in a spiral. In eight-rowed corn the breaking of the cob discloses a four-sided appearance; in the ten-rowed, a five-sided appearance, and so on, as I have indicated in my diagrams published in the New York Experiment Station Report for 1884. Suckering is of frequent occurrence, and is greatly stimulated by an open exposure and a highly manured soil. Japanese striped is an excessively suckering variety. In a digitate ear of Waushakum corn I once found some podded kernels, and also once in an otherwise normal ear of eight-rowed New England.

The Sorghum varieties "Dhaura," "African wheat" and "Millo maize" have a structure of kernel corresponding to the flint corn type.

IV.

Zea indentata, the Dent corns, N. Y. Ex. Sta. 1884, 172; 1886, 59, fig.

The split kernel exposes the chit, corneous matter at the sides, the starchy matter extending to the summit.

Turcicum frumentum Dod. frum. 1566, 74, and also as copies; *Milium Indicum* Lob. obs. 1576, 24; *Frumentum turcicum* Dod. pempt. 1583, 500; 1616, 509. *Milium Indicum Plinianum* Lob. ic. 1591, 39; *Frumentum Asiaticum* Ger. 1636, 81; *Milium Indicum maximum*, Park. th. 1640, 1138; *Triticum Peruvianum album longum* III, J. Bauh. 1650, 2, 454; *Triticum Peruvianum* Chabr. 1666, 174; 1677, 174.

Frumentum indicum granis luteis Weinm. phyt. 1739, t. 518.

Frumentum seu milium indicum granis rubentibus Weinm. l. c.

I find no vernacular names for this species other than "dent" in America. A soft corn, through rapid drying, may form a crease or a dent in its kernel, but a split kernel, which at once

shows absence of corneous matter, determines the species. The dent corns furnish the bulk of our commercial supply for home use and export. The varieties grown for this purpose belong almost exclusively to sub-species C., and often have very many rows, even to the number of forty-eight. The poketawes or hokotawes of the Powhattan Indians, 1608, was a horse-tooth dent. The most northern locality represented in my collection is North Dakota, an eight-rowed form, sub-species A. The amarillo of Peru, as described by Tschudi, I take to be a dent. In a Chilian collection kernels with corneous sides and sweet at summit indicate the presence of dent corn in that country. The *milho catete vermelho*, of Brazil, is a dent.

The Early Adams is a variety in which the irregularity of the kernel arrangement is characteristic. The Extra Early Adams, sub-species C., is reported as ripening at Ottawa, Canada. One variety grows from African flint seed, through atavism, had kernels armed with a short, sharp, stiff spine where the silk was attached, but this peculiarity was not reproduced in the growing. A red-husked dent is sold by our seedsman, and from Dr. Palmer, in 1886, I received two red-husked varieties among seven dents collected from the San Padro Indians of Mexico. Some varieties are described as bearing many ears to a stalk, seven to eight in the Baden, six to eight for Blount's Prolific. I have seen as many as nine good ears on a stalk of this variety. These varieties are also much subject to suckering, as seems also the Chinese tree-corn, which is described as branching. The formation of adventitious roots is very noticeable in this species, although not confined to the dent group. There is also a strong tendency in the dent for the ears to hang downward at maturity, thus protecting the kernels from the weather. From Dr. Palmer I received from the San Padro Indians one sample, five almost bunched ears, the terminal one about five inches long and kernel-bearing, and within a space of three inches below were four alternating unfruitful ears. As will appear elsewhere, we have noted the appearance of podded ears on the normal *Zea tunicata*, in a crop of Blount's Prolific.

In the variety of Sorghum called "Neeazana" we have a structure of kernel similar to the dent corn.

V.

Zea amylacea, the soft corns, N. Y. Ex. Sta. 1884, 181 ; 1886, 59, fig.

The split kernel shows only the chit and starchy matter, corneous matter being entirely absent.

Zea erythrolepsis Bonafous, mais, 1836, 30 (Tuscarora).

Zea macrocarpa Klotz. Bot. Zeit. 1851.

Maizium, Peter Martyr, 1493, in Eden's Hist., Trav. 1577, 10.

Fru mentum turcicum Dod. frugum, 1552, 35 ; Lyte's Dod. 1575, 464. The same figures, *Triticum indicum*, J. Bauh, 1650, 2, 453.

Fru mentum Indicum Matth. comm. 1570, 305 ; Calceol. 1571, 164 ; the same figure, *Triticum indicum* Matthioli, Lugd. 1587, 1 : 382.

Fru mentum Indicum Cam. epit. 1586, 181. The same figure also in Uffenb., 1609, 398 ; Becher, 1662, 147 ; Verzasch, 1678, 172 ; Zwing, 1696, 323.

In my collections this species shows a greater variety of shades and colors than any of the others, and is the principal sort grown by the Indians of Mexico. Hence we can refer to Hernandez, who in his history, 1651, mentions white, pale, black, purple, yellow, blue and mixed colors ; also a very long ear with glistening white, large and tender seed, as Mexican varieties. His figure under Tlaolli seu maizio, p. 242, is the same as *Aliud milium indicum magnum* Lob. ic. 1591, 40, and *Fru mentum turcicum* Ger. 1636, 81. His Tlaolli seu maizio, p. 243, is the same figure as *Milium indicum rubrum*, Lob. ic. 1591, 40, and *Fru mentum indicum luteum*, Ger. 1636, 82. Tabernæmontanus in his history, editions of 1588 and 1613, and Icones, 1590, figures under *Fru mentum turcicum* five varieties which may be flint ; under *Fru mentum indicum* fourteen varieties, black, purple, blue, red, yellow, white, mottled, variegated and many-colored, and the figures suggest a soft corn. The same figures appear in Gerarde's herbal, 1597, but the names badly transposed or different. *Fru mentum Indicum* Tabern. 1588, 760, 761 ; 1613, 641 ; ic. 1590, 265, is copied in Bauhins' editions of Matthiolus, 1598, 319 and 1674, 319 ; in Gerarde, 1597, 75, called *Fru mentum Asiaticum* ; in the second edition of Gerarde, 1636, 75, it is called *Fru mentum Indi-*

cum cœruleum; in Bauhins' theatre, 1658, 459, *Fru mentum indicum mays dictum alterum*; and an apparent copy in Morrison oxon. 1699, s. 8, t. 13, f. 1, is labelled *Fru mentum indicum mays dictum*. Peter Martyr, in his first decade, written in 1493, describes the maizium of Hispaniola as a black, pea-size grain, which when broken is "whiter then snowe," and hence a soft corn. De Vega, in his Royal Commentaries, says the ancient Peruvians had a sort called *capia*, "tender and highly esteemed." The mummy corns that I have seen from Peru have been soft corns. Dobrezhoffer says the Guaranies of Paraguay had an *abati moroti*, which consists of very soft and white grains. The maize found by Darwin imbedded with shells and rubbish on a terrace 85 feet above the beach in Peru, he declares identical with the kind found in the Peruvian huacas. In the Tusayan pueblo (New Mexican) flute ceremonial legend, as given by Matilda Coxe Stevenson, occurs the following passage: "He then placed a yellow ear of corn to the north of the bowl, a blue ear to the west, a red ear to the south, and a white to the east; a black for the zenith was placed by the side of the yellow ear, and the all-color for the nadir by the side of the red ear." In these colors we seem to recognize soft corn, especially as in the Zuni collection of soft corn we have these colors, and the same varieties in the same color I have seen in soft corn brought to Santa Fé by tourists from the Tesuque pueblo, nine miles distant. Du Pratz, in his history of Louisiana, 1763, mentions as a variety "flour maiz, which is white, with a flat and shrivelled surface, and is the softest of all kinds."

The soft corns have a wide distribution, and seem to have been popular with Indians, as the kernels are readily broken down into flour. I have recognized it from Manitoba in the North; in specimens from the cliff dwellings and as in cultivation in eleven varieties by the Southwestern tribes; in the Omaha corn of Nebraska; the Squaw corn of Michigan; the Wyandotte of Illinois; in the Tuscarora in three colors from North Carolina; in Mexican Indian corn in thirteen varieties; in the maizium described for the West Indies; in two varieties described in Peru; in the mummy corn of Peru; in five varieties from Chili, including the Cuzco. This latter is the largest kernalled corn known, some collections

showing kernels an inch long, correspondingly broad and thick. It is described as having many varieties, and five colors are named by Markham.

But few sports have come under my observation. In 1885 an ear of Zuni yellow was grown with a tassel protruding from the apex. The Wyandotte suckers so freely as to be said to tiller like wheat; it also bears many ears to a stalk; one sample from the San Pedro Indians had a branch with one terminal ear, and four ears bunched a short distance below.

The variety of Sorghum called "Chinese sugar cane" has seed floury throughout and without corneous matter, like the soft corns.

VI.

Zea saccharata, the sweet corns. N. Y. Exp. Sta., 1884, 156; 1886, 59, *fig.*

The kernel of this species has a semi-transparent or translucent, horny appearance, and is more or less crinkled, wrinkled or shrivelled.

Zea mays rugosa Bonafous, Mais. 1836, *t. II.* (An eight-rowed sweet.)

The earliest reference to sweet corn that I find is in the Zuni myth, as given by Cushing, quoted by Harshberger, where it is said that the oldest sister was yellow corn; the second, blue; the third, red; the fourth, white; the fifth, speckled; the sixth, black; the seventh, sweet corn. The six colors were in the Zuni collection sent me by Mr. Cushing, but there was not a sweet corn among them. The first sweet corn in American cultivation was the papoon corn, an eight-rowed variety with a reddish cob, first introduced to the region about Plymouth from the Indians of the Susquehanna in 1779. It belonged to sub-species A. Tschudi, who was in Peru 1839-42, describes a sweet corn apparently of sub-species C., under the name *Amarillo de chancay*. The Black Mexican was described by Burr in 1863, its name indicating origin. Under this name two varieties are now grown, one of sub-species A, the other of sub-species B.

The distribution into culture was slow. It was not mentioned by Jefferson in his notes on Virginia in 1781, nor by writers on

American gardening in 1806, 1817, 1818, 1819, 1821 and 1828; nor by Seringe for Switzerland in 1818; nor by Metzger for Germany in 1824; nor by Noisette for France in 1829. Bridgeman mentions one variety in 1832, as does Buist in 1851. The original eight-rowed form, and another like it, but with a white cob, is mentioned in 1853; in the Patent Office Report, 1853, the Mammoth Sweet and Stowell's Late Green are named. Schenck, 1854, knew two varieties; Klippart, 1858, six varieties; Burr, 1866, twelve varieties. In the New York Station Report, 1884, I described and figured thirty-three varieties. One variety, the Ruby Sweet, of recent introduction, has red husks.

Sweet corn kernels are usually all corneous; sometimes, however, a small quantity of starchy matter is visible. I suspect that a fuller study may unite the sweet corns as variety forms of pops, flints and dents. In the New York Station Report, 1884, 131, mention is made of some kernels flint on the chit face and sweet on the opposite face. Then, again, in my Chilian collection were some kernels corneous at the sides and sweet on the summit. My *Zea amyleasaccharata* may perhaps be also mentioned as a form of variation. I have observed but few monstrous growths. I once received a plant of Stowell's Evergreen but 12½ inches tall, well formed, of vigorous green, leafy, and bearing three unripe ears, two of which were kernelled. These two ears were hermaphrodite, the ovule and stamens within the same glume. We have also record of podded kernels being found in a crop of this species.

VII.

Zea amyleasaccharata, the starchy-sweet corns. N. Y. Ex. Sta. 1886, 60, fig.

This species is founded upon three varieties found in the San Pedro Indian collection of Dr. Palmer and sent me in 1886. The external appearance of the kernel is that of a sweet, but examination shows that the lower half of the kernel is starchy, the upper half horny and translucent. These varieties had all a white cob, the kernels deeper than broad, or sub-species C.

1. Ear fusiform, kernels rounding towards a small stalk, 7 inches long by 1¾ inches in diameter at largest part, 16-rowed.

Kernels translucent yellow, flat at summit, deeply shrunken at top and sides, no sulcus between rows. The most attractive sweet corn I have ever seen.

2. Ear fusiform, rather pointing at tip, kernels rounding strongly towards a smallish stalk, 5 inches long by $1\frac{7}{8}$ inches in largest diameter, 18-rowed, kernels much deeper than broad, very thick, wrinkled, of a translucent yellow. No sulcus between rows.

3. Ear slightly fusiform, kernels rounding gradually to a small stalk, 5 inches long by $1\frac{3}{4}$ inches in largest diameter, 16-rowed. Kernels translucent yellow, quite golden, wrinkled. A deep sulcus between the rows.

The crop failed to mature at Geneva, N. Y., and thus the seed was lost. The plants grew very tall, and were only at the bloom when fall frosts came.

VIII.

Zea tunicata, the Pod corns.

In this species each kernel is enclosed in a pod or husk, and the ear thus formed itself enclosed in a husk.

Zea mays tunicata St. Hil. Ann. Sc. Nat. 16: 143, fide DeCand.

Zea cryptosperma Bonafous, Mais. 1836, t. 5.

Zea mays vaginata, N. Y. Ex. Sta. 1884, 186, fig.

Frumentum indicum grano avellano magnitudine, C. Bauh, 1623, 24; J. Bauh, 1650, 2, 454; Moris, Oxon. 1699, 3, 248.

Frumentum indicum majus grano avellanæ, C. B., J. B., Moris, Oxon. 1699, 3, s. 8, t. 13, f. 2.

Æthiop Manigette, Mentz. Index, 1682, 122.

The vernacular names I have noticed are: California corn, Cow corn, Forage corn, Husk corn, Oregon corn, Pod corn, Primitive corn, Rocky Mountain corn, Texan corn, Wild corn. In Africa, manigette (C. B., 1623); in Buenos Ayres, pinsingallo (Bonafous).

The Bibliography of this species, additional to that given in the list of synonyms, is as follows: Teschemacher, Proc. Boston, Soc. of Nat. Hist. Oct. 19, 1842; Lindley, Jour. Hort. Soc. 1846, 115, fig.; Salisbury, Trans. N. Y. Agr. Soc. 1848, 837; U. S. Pat. Office Report, 1853, 98, fig.; DeCandolle, Geog. Bot. 1855, 951; Orig. des Pl. Cult. 1883, 316; Klippart, Agr. of Ohio, 1858, 24.

fig.; Darwin, *An. & Pl. under Domes* [1868] 1, 386; Carman, Moore's *Rural New Yorker*, Mar. 3, 1877, *fig.*; Sturtevant, *Trans. N. Y. Ag. Soc.* 1879, 37 and reprints or excerpts, 1879, 21; 1880, 21; *N. Y. Ex. Sta. Reports*, 1882, 54; 1883, 40; 1884, 142, 186, *figs.*; 1885, 95; 1886, 64; *Science*, 1883, 1: 234; Wittmack, *ueber anteken mais, etc.*, in *Berlin, Anthrop. Ges. Nov.* 10, 1879; Landreth *Seed Catalogue*, 1889, *fig.*

DeCandolle, who investigated its history up to 1835, quotes the Abbe Larranhaga as saying that the Guaycurus Indians cultivate it, but according to St. Hilaire this tribe is not agricultural. A young Guarany, who recognized this maize, said that it grew in the humid forests of his country. Bonafous received the seed from Buenos Ayres under the name pinsingallo. Lindley received seed from New York said to have come from the Rocky Mountains. C. Bauhin, 1623, gives an African name, manigette. The seed is occasionally supplied by our seedsmen as a curiosity for growing in the garden, and doubtless the names California corn, Oregon corn, Rocky Mountain corn and Texan corn indicate sources from which seed have been procured, but without necessarily implying origin. It is very rarely grown even by the curious, and but few farmers have seen it. A Mr. Bullard, of Ohio, on seeing some specimens for the first time, expressed surprise at the ear, but said he had frequently found single kernels podded in his crop of dent corn. May 18, 1884, J. W. Nicholson, Camden, N. J., wrote me that he had now planted Blount's Prolific [dent] corn, the original seed from the Department of Agriculture at Washington for four years, and that each successive year he had found more and more pod corn in his crop. The samples he sent me were ears of fully podded corn of the Blount's Prolific type. December 9, 1885, I received a number of ears of a podded flint corn from Ohio, and one of these ears had kernels twinned in the pods. In the specimens of *Zea canina* sent me by Professor Watson, I note kernels of podded corn of the rice pop type. In *Science*, 1894, 109, is an account of "an ear each grain of which had a distinct shuck" from a planting of "ordinary sugar corn." I have myself found podded kernels on a digitate ear of Wau-shakum flint, and also on an otherwise normal ear of a common New England eight-rowed flint, and have raised podded sweet

kernels from a white dent ear raised from a red unpodded ear of pod corn. From yellow dent seed, sub-species C, were grown sweet, flint and dent corns with the podded character, and sweet, flint, dent and soft corn in unpodded ears. The variables noticed were tassel corn, ears with kernels uniformly and lightly husked, heavily husked, fastigiate ears, unpodded ears, cone-shaped ears, cylindrical ears; kernels white, yellow, red and striped. From podded seed, 166 plants yielded 76 podded and 29 unpodded ears and one tassel ear. The presence of smut diminished the yield to a large extent. The number of rows on unpodded ears varied from 12 to 24.

The description of the dent plants bearing the podded ears is: Strong growing, ordinarily from 8 to 10 feet tall, exceedingly leafy, inclined to sucker, adventitious roots at lower nodes, the crop borne about four feet from the ground, on the fifth to seventh node from the top. Tassel very heavy, the branches long and drooping, not rising very high above the foliage, very frequently kernel bearing, the grain either bare or podded. Ears variable in length and form. In the heavily podded samples the cone shape with imbrication is prevalent; as the podding becomes lighter the ears tend more towards the cylindrical, but even in wholly unpodded ears the cone-shape occasionally persists. In some cases a fastigiate group of husked ears at the but, changing to heavily podded kernels as we near the tip; in other cases the outer husk embraces a whole cluster of ears, which in our growing were too late for crop. Cobs in the heavily podded ears very flimsy, when dry tending to break readily into short pieces; in the fastigiate specimens even more flimsy; in the lightly podded forms larger and less loose, even to the ordinary hard and dense cob of the common form. Kernels in heavily podded samples, being removed from pressure, are more rounded than in their unpodded form, and often distinctly pointed towards the place of insertion on their cob, the distichous arrangement often very pronounced; occasionally two or even three kernels in a common pod. The corneous matter is very hard and flinty. The pods are variable in length, usually white, occasionally brown or red-tinged.

In favor of *Zea tunicata* being closely allied to a primitive form we may call attention to the appearance of podded kernels on ears

of our other species, as recorded here for pops, flints, dents and sweets, which suggests atavism; to the flimsiness of the cob and its occasional readiness to disarticulate; to the tendency towards fasciation or clustering in the ears; to the hardness of the corneous matter in the kernels; to the protective character of the pods as against insect and bird depredation, as favoring distribution of the seed under natural agencies, as favoring germination, through retention of moisture of seed dropped on the surface of the ground, as protective against weevil infection. It is almost certain, says Darwin, that the aboriginal form would have had its grains thus protected.

As a wild plant this species has been insufficiently recorded from Paraguay, and also in the form of *Zea canina* from Mexico. Heller writes: "We often find in Mexico single plants of maize which grow self-sown, and flourish without culture; and though they may stand miles from any inhabited place, they cannot be considered wild, as, notwithstanding the often monstrous variety, they always bear the characteristics of cultivated maize." Professor Watson quotes Professor Brewer's letter to me, in which he says that a well-known German collector, a Mr. Roehl, told him in 1869 that "he found in the State of Guerro a *Zea* which he thought specifically distinct and undescribed, the ears very small, in two rows, truly distichous, the ear (but not each grain separately) covered with a husk, the grain precisely like some varieties of maize, only smaller and harder." Professor Watson thinks this probably the same as his *Zea canina*. Professor Duges, in sending this *mais de coyote* to Professor Watson, mentions that "a pop corn, *mais rosero*," is cultivated in the same region, a fact of some significance.

We hence are inclined to believe that when a truly wild *Zea* is discovered it will be of a podded form, the kernels small and very flinty. It will be recalled that in our trial of vegetations pop corn seed held the supremacy, and that pop corns showed the strongest vitality in regenerations after air-drying.

IX.

When we consider the number and the perfection of the varieties of maize, we cannot but recognize that a long antiquity and

extended cultivation were requisite for their differentiation. For various reasons I am disposed to consider *Zea everta*, of our cultivated species, the nearest to the primitive form, and *Zea amylacea* as the furthest remove from the primitive form; the Cuzco corn of Peru and Chili the most improved class of variety. The next most highly developed varieties seem to be the horse-tooth softs of Chili. The largest number of species represented in any one Indian collection is four, in fifteen varieties, from the San Pedro Indians of Mexico, seventeen ears which excelled in perfection of form any like number collected from any one locality or from seedsmen. The next largest number of species is the three, in eight varieties, from the Tarahumarer Indians of Mexico, "the timid Tarahumari," as Harshberger quotes, "a savage race, living mostly on the cliffs, and planting a little corn without cultivation on the steep hillsides, and not otherwise tillers of the soil." It is unfortunate that our collections from South America are so limited, as Peru excels in species and varieties noted in the table gleaned from our readings.

If we look upon agriculture as a pursuit which yields a food supply requisite for the maintenance of a population, then the American Indian was an agriculturist wherever with suitable climate tribal strength or location availed to protect his crops. When Gen. Sullivan, in 1779, made his invasion into the Indian country of Central New York, the Indians were subdued through the destruction of their food supplies rather than through their losses in battle. In perusing the journals of this expedition we find continual mention of the seizure of corn, of large fields, of abundance of corn, and at the present Genesee the destruction of 20,000 bushels. In the earlier invasion of this region by De Nouville, in 1687, some 1,200,000 bushels of corn are said to have been destroyed, and in 1696 Frontenac, in the country of the Onondagas, employed his army for three August days in destroying the growing corn, which extended from a league and a half to two leagues from the fort. In the Pequot war, in 1636, the English destroyed 200 acres of corn on Block Island, R. I., alone; and in the King Philip war, in 1675, the Puritans harvested a thousand acres as spoils.

When Cartier reached Hochelega, the present Montreal, in

1535, he found the town surrounded by extensive cornfields. In 1605 Champlain mentions fields of corn at the mouth of the Kennebec river and along Cape Cod. In 1609 Hudson found "a great quantity of maize" among the Indians of the river of his name. The Pilgrims, in 1620, found "fifty acres" of field in one place, and "new stubble" elsewhere in their early reconnoissance of their country. In 1634 John Oldham bought 500 bushels of the Narragansett Indians, who had promised him a thousand. In 1747 Cobden says the Five Nations made planting of corn their business and supplied more northern tribes, and in 1794 Gen. Wayne wrote of the Delawares, of Ohio, "nor have I ever before beheld such immense fields of corn."

In the early settlement of America every European colony seems to have been dependent upon corn bought or seized from the Indians, and every march of invasion was rendered possible by the corn found in the Indian granaries or taken from the growing plants. De Soto's march from the east discloses corn in crops throughout his course, as did Coronado's march from Mexico to Kansas, wherever climatic conditions permitted.

Columbus found maize in the West Indies on his first voyage, in 1492. In 1498 he reports his brother passing through eighteen miles of cornfields on the Isthmus, and the same year he found maize in Venezuela. At Zobabra, 1503, Diego Bartholemew saw above six leagues of cultivated corn. Cornfields and corn are also mentioned in Central America by Pascual de Andagoya in 1516. In 1518 de Encica mentions maize and roots as constituting the food of the Amazons, and in 1520 the ships of Magellan were supplied with maize at Rio Janeiro. Cieza de Leon, who travelled in Peru, 1532-50, continually speaks of fields of maize, as do more modern travellers, and the remains of irrigation conduits attest the antiquity and extent of its culture. Thevet, 1558, describes maize in Brazil, as does Lery, 1594, and Nieuhoff in 1647. In Chili maize was the ordinary diet, as Alonzo de Ovalle wrote in 1649. In Mexico the sixth and seventh centuries of our era represent the Toltec period, and the Olmecs are thought to have raised maize before the time of the Toltecs.

The antiquarian evidence is the finding of charred corn and cobs in Indian mounds in Ohio, Missouri and elsewhere, and in

the ears and grains found enclosed with the mummy burials in Arizona, New Mexico and Southern Utah. Charnay reports representation of ears of maize on some ancient statuary in Mexico. Brocklehurst figures the vase of Centeotl with its ear of corn, and hieroglyphics on the monuments at Palenque indicate that maize was an important food in Yucatan. The Smithsonian Institute has an ear of corn found in an earthen vessel eleven feet under ground in a mummy grave near Arequipa in Peru. Tschudi describes two kinds taken from tombs apparently prior to the dynasty of the Incas. Squier found not only the grain, but an ear carved out of a variegated talc within a mummy covering at Pachacamac, where also spikes of maize were observed by Pickering. A harvest vase of maize from the ruins of Chemu, near the present Truxillo, shows the heads of children peeping out among the corn cobs, as Markham writes. In 1835 Darwin found on the coast of Peru heads of maize together with eighteen species of recent sea-shells embedded in a beach which had been upraised at least eighty-five feet above the level of the sea, and these relics he pronounced identical with those taken from old Peruvian tombs. At Tarapaca, in 1874, beneath the volcanic formation called Chuco, were found cobs of maize buried with a mummy.

In what locality did the cultivation of maize originate. Our data is as yet too imperfect for reply, as we have little record of the varieties that are at present grown either in Peru or Mexico, between which places our choice seemingly is to be made. The evidence of the more ancient presence of maize in Peru in the finding of specimens in geological deposits is superior to that tabulated for Mexico. The finding of a wild corn (probably an escape) in Mexico, is a little more certain than the Indian testimony of wild corn in Paraguay. The superior development of varieties, as the Cuzco of Peru, and the Cuzco and horse-tooth soft forms of Chili, is strong evidence in favor of a South American origin. The rice pop found in Peruvian sepulture, and as growing in Paraguay, is also in evidence; but the rice pop form is present in *Zea canina* of Mexico.

The antiquity of the culture must be great as measured by years, for Darwin's variety from a geological deposit was pro-

nounced identical with that buried with the ancient Peruvians, and this corn, so far as we have seen it, is *Zea amyloacea*, the most divergent of our species from the primitive form; but *Zea everta*, rice form, is the least divergent and is also found among the relics of the tombs. So the indefinitiveness of mention, even by such an eminent observer as Darwin, leaves uncertainty.

X.

The environmental relationships of maize seem to have been but little studied, and are very obscure. Seed sown on the surface, through the property of regermination, will frequently vegetate, as will also seed sown at a depth of eight inches or more. When the seed is planted in ground of a low temperature, although the germination process will go on at 42° or 43° F., yet the progress is so slow that mould often destroys vitality before vegetation can occur, while at a high temperature progress is so rapid that this danger is escaped. In the *Scientific Farmer*, October, 1878, I called attention to the embryo ears on a cornstalk, and gave a figure. These embryo ears usually all but one remain dormant when the crop is close planted, but are inclined to develop as openness of planting increases. By mutilating the plant in various ways these dormant ears may be stimulated into development, the lower ones especially, into branches with a terminal ear. Compressing the upper portion of the stalk is often followed by kernel formations on the tassels, and a ligature applied to an ear has been followed by the development of a tassel on the extremity. Suckering in the corn plant is the development of dormant buds, and is furthered greatly by openness of planting and fertility of soil, although in some varieties, like the Wyandotte soft and the Japanese striped flint, it becomes a characteristic which can scarcely be checked. The relation of the plant to climate is difficult to define. The influences often ascribed to climate seem usually to be the result of a variety characteristic, or changes induced by unconscious selection. Some Mexican Indian corn was represented to me by Dr. Palmer as growing to about the height of a man, and as being early maturing. Planted in New York in May, the plants were about eleven feet tall and just approaching bloom in October when cut down by frost.

Zea canina, as grown at Cambridge by Professor Watson, was ten feet tall, and suckered greatly ; as grown by Harshberger, at Philadelphia, it was but five feet tall, and tillering is neither noted nor figured. Moisture seems to develop height, aridity to dwarf. When weeds, the great robbers of moisture from land, are allowed to develop freely in a cornfield, a moist spot will frequently bear corn of the normal height, while a neighboring drier hillock yields only dwarfed and stunted specimens. On the other hand some varieties seem to remain dwarf under all conditions observed. The tallest forms are recorded from hot and moist tropical regions, but so also are low-growing varieties.

Contributions to American Bryology.—VIII.

BY ELIZABETH G. BRITTON.

A REVISION OF THE GENUS BRUCHIA, WITH DESCRIPTIONS OF TYPES, AND ONE NEW SPECIES.

(PLATES 213-217.)

BRUCHIA Schwægr. Suppl. 2: 91 (1824).

PHASCUM Schreb. De Phasco Obs. (1770) in part.

SPORLEDERA Hampe, Linnæa, 279 (1837).

The genus *Bruchia* was founded by Schwægrichen in 1824 for *B. flexuosa*, which had previously been described under *Phascum* from specimens sent by Muhlenberg. The type species, therefore, is American, and the genus reaches its greatest development in North America, only two European species being so far known. Several have been described from Central and South America, and three from South Africa.

Müller in his Synopsis Muscorum, 1849, recognized 7 species, of which four were American, and subdivided the genus into two sections:

I. SPORLEDERA Hpe. (*B. Beyrichiana*, *B. palustris*, *B. brevipes*).

II. EUBRUCHIA. (*B. flexuosa* and var. *minor*).

In the first section he placed the subcaulescent species, and in the second the taller, stemmed species with exserted capsules and long necks.